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BIOLOGICAL STUDIES ON THREE FORMS OF THE TWO-SPOTTED SPIDER MITE

(Acarina: Tetranychidae)

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According to McGregor (1942) the appropriate name for the two-spotted spider mite is *Tetranychus bimaculatus* Harvey, although names such as *T. telarius* (Linn.) or *T. urticae* Koch are often used by other workers. Actually, however, the two-spotted spider mite, as it is currently determined is a complex of species or strains which differ from one another in color, host range, ability to cross breed, or some small morphological characters. The present study is concerned with biological studies of three forms of spider mites, two of which were determined by E. A. McGregor as *T. bimaculatus*. The third form, taken on a potted hydrangea plant from San Francisco, was stated by A. E. Pritchard to be a member of this complex.

Little morphological evidence was noted to separate the three forms, aside from very slight differences in the aedeagus. A. E. Pritchard (personal communication) found that one form could be distinguished from the other two by the chaetotaxy of the front legs of the female. A ring of six setae occurs at the base of the front tarsus (fig. 1) and thirteen setae occur on the front tibia of the females of this form. In contrast to this, females of the other two forms each have a ring of four setae at the base of the front tarsus (fig. 2) and ten setae on the front tibia. The fore legs of the males of all forms have six proximal setae on the tarsus and thirteen tibial setae. For convenience in this paper the forms will be referred to as "six-setae,"[1] "four-setae" and hydrangea mites.

Color, while often of limited use in mite taxonomy, may be important in the case of spider mites. Ewing (1914) conducted feeding experiments and reached the conclusion that yellows, greens and brown of the "common spider mite" are variations due

[1]Since this paper was submitted for publication, the name Tetranychus multisetis McGregor has been given to the mite referred to as the "6-setate" form herein. See E. A. McGregor, 1950. Mites of the Family Tetranychidae. American Midland Naturalist, 44(2):257-420.

to nutrition, but orange and red shades are constant and will not change even after death. Ewing as well as Cagle (1949) stated that the dark areas on the mites vary in size, shape and number due to nutrients.

Adult females of the three forms of mites discussed in the present paper were red at all times and under all the experimental conditions. In no case were females observed to exhibit the pale yellowish-orange color of overwintering females of certain other spider mites, nor were shades of brown and green encountered.

In an attempt to see if color could be used for separation of the individual forms under study, a mixed colony was started. The extremes in intensity of red were later isolated and mounted, but no correlation was found between the selections and the number of setae on the tarsus.

There is a difference in the color of the males, however. The males of the hydrangea mite are a distinct red which is nearly the same color as the females. The males of the other two forms are never a true red, but are more nearly flesh colored.

Extensive measurements of length were made on all life stages of these three forms of mites, but no significant differences were found. Life history studies showed no great differences in duration of the life cycle or the number of offspring.

As far as it could be determined, there is no difference in the host range of the "four-setae" and "six-setae" forms. The hydrangea mite, however, exhibited a distinctly different host range as it is the only form capable of surviving on hydrangea leaves, and the only one not capable of feeding on the surface of banana squash fruit. All three forms could live and reproduce well on bean leaves. Strawberry and violet could support all three forms, but were unsatisfactory as experimental hosts.

In order to determine if the setal characters were simply genetic variations within a single species, a mixed colony of "4-setae" and "6-setae" mites was established, and 73 adult females were taken at random from this mixed population. These females were in all probability fertilized individuals. All 73 females gave rise to colonies, and 60 of these colonies were successfully carried to F_1 adults. Of these 60, twenty-two had "4-setae" female parents, and 38 had "6-setae." In every case there were female offspring, and all examined were of the same type as the female parent. Wherever possible six or more F_1 females from each colony were mounted

and compared with the female parent. All together some 200 F_1 females were studied. In all cases the female parents were removed and mounted prior to the emergence of the first female F^1. Some of the colonies were carried into F_2 and F_3 generations, but the females always remained of the same type as the original female parent.

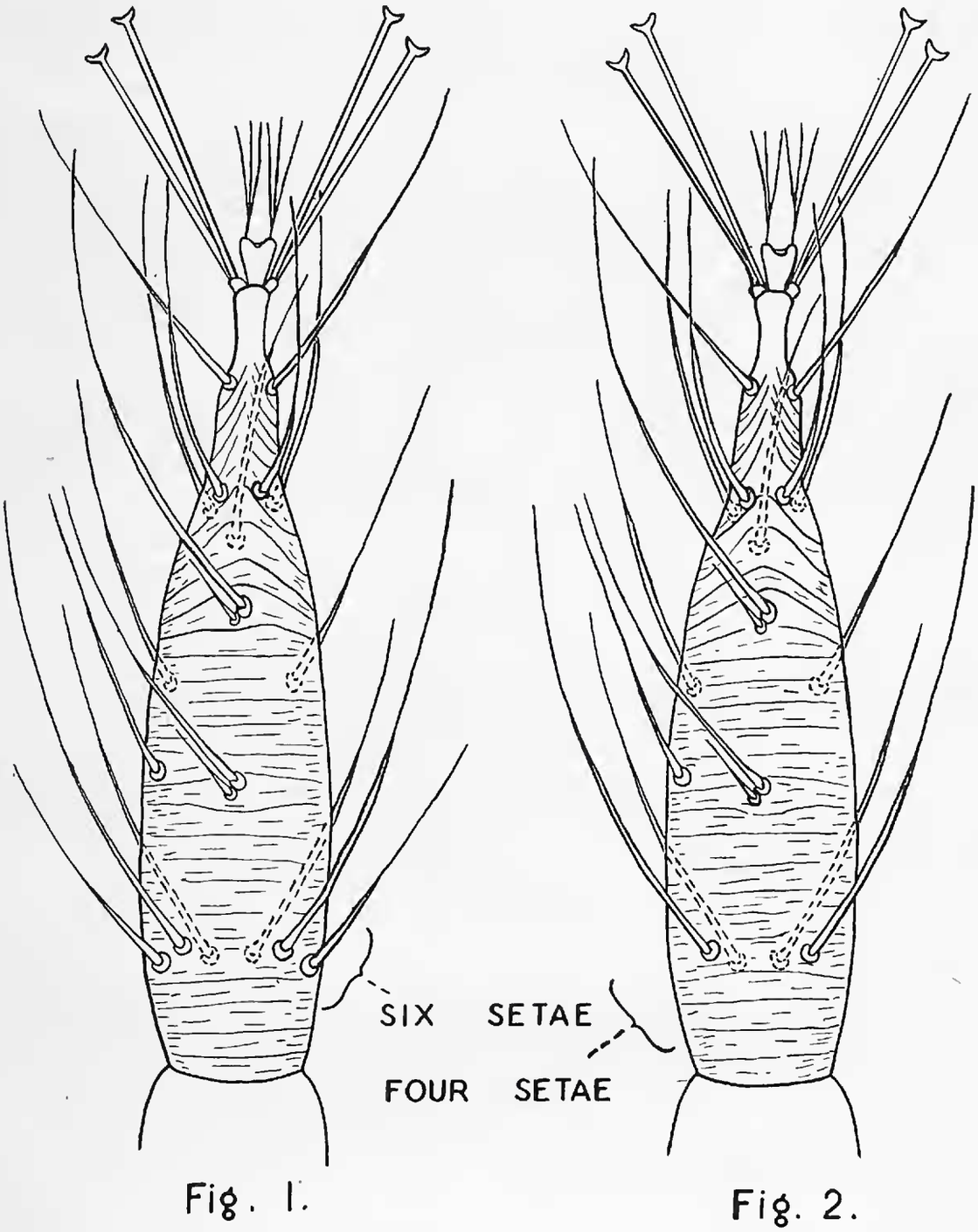

Fig. 1. Fig. 2.

Fig. 1. Dorsal view of the front tarsus of a female spider mite of the "six-setae" form. X 600.

Fig. 2. Dorsal view of the front tarsus of a female spider mite of the "four-setae" form. X 600.

A series of crosses was made to determine whether or not these three forms of mites would cross or whether they were genetically isolated. Colonies which had been started from single females, were maintained as a source of pure stock throughout the series of experiments. The hydrangea mite stock was kept on hydrangea leaves, and the other two forms were reared on banana squash. Periodically slide mounts were made and examined to be certain that the stock remained pure. In addition the female parents of each cross were mounted and examined for any possibility of contamination.

The technique used involved isolation of female deutonymphs. This guaranteed adult females to be virgins, as fertilization takes place only in the adult stage. Most of the crosses were made in single leaf cages on either bean or hydrangea leaves. The type of cage employed was developed by the Division of Biological Control, California Agricultural Experiment Station at Riverside, California, and has been used extensively both at Riverside and at their station at Albany, California.

The cage consists of a backing of waterproof ply-wood which is bordered by a strip of rubber. Inside this rubber barrier is placed a square piece of blotting paper covered with cheese cloth. A detached leaf is placed on the cheese cloth, and over this a fairly thick piece of plexiglass with a 1½ inch hole is placed to form a cell in which mites can be reared and studied. The plexiglass is held down and in place with rubber bands. The cell is covered by a thin sheet of transparent plastic fused to the plexiglass with acetone. The leaf used must be large enough to completely cover the base of the cell. The leaf is kept fresh by adding moisture to the blotter daily, or at least every second day. Bean leaves survived up to three weeks in these cages, and hydrangea leaves up to seven weeks.

To make crosses between the "four-" and "six-setae" forms, mature males and female deutonymphs were taken from the above colonies which had been established from single females. In interpreting the results of the cross-breeding experiments, it must be recognized that unfertilized females produce males only, while fertilized females produce both males and females, but with a preponderance of the latter.

Twenty-eight crosses were made between the "four-setae" and "six-setae" stocks. Sixteen of these were between "four-setae" females and "six-setae" males, and 12 were the reciprocal. Twelve of the crosses failed to produce adult offspring. Of the 16 remain-

ing crosses, 15 contained female and male offspring in a normal proportion. In every case the female offspring were of the same type as the female parent. In three of the colonies the F_1 individuals were inbred and carried through several generations. In every case the females remained the same type as the original female parent. In one cross of the original 16, there were no female offspring. Only one male was used in each cross, and it is possible that in this case the male was injured or killed so that copulation did not take place.

Further investigations were conducted in which hydrangea mites were crossed with the other two forms. A total of 18 crosses was made in which three female deutonymphs and two or three adult males were used in each cross. Four crosses were made on bean leaves, and 14 crosses were attempted using hydrangea leaves. Due to the fact that the "four-" and "six-setae" forms will not survive and reproduce on hydrangea leaves, the latter crosses all employed female hydrangea mites and males of the other forms. Several instances of copulation were observed. Of all the attempted crosses, only males were obtained, and in some cases more than 50 males were present in the F_1 population. All of the crosses employing hydrangea females gave rise to red males of the hydrangea type. The other crosses gave rise only to flesh colored males.

SUMMARY

The two-spotted spider mite[2], as currently determined, is a complex group. Three forms which were determined as belonging to this complex formed the basis of the present study. The females of all three forms were red under all experimental conditions.

A form which occurs on hydrangea was shown to be unable to cross with either of the other two forms, as evidenced by the lack of females in the F_1. The hydrangea form further differs from the others in host range, as it lives on hydrangea but is unable to survive and breed on banana squash. The males are red in this mite but not in the others.

The other two forms studied differed in the chaetotaxy of the front legs of the female. However, no differences in host range or habits were observed. On crossing these two forms, offspring of both sexes were obtained. The inheritance of the setation, however, is unique in that it was found to pass down from mother to daughter, regardless of the male used.

[2]See footnote 1.

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A LARVA OF TRICHODES ORNATUS FROM A POLLEN TRAP ON A HIVE OF HONEY BEES

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An apparently full-grown larva of *Trichodes ornatus* (Say) was found in December, 1950, in a tight honey tin containing stored pollen. In June of the same year this pollen was taken from a pollen trap on a hive of honey bees at North Logan, Utah. It is reasonably certain that the clerid larva was subsequently transferred from the pollen trap into the can of pollen.

Linsley and MacSwain,[2] who studied the life history of this clerid, found no records of it as an inhabitant of honey bee hives, although *Trichodes apiarius* (L.) has been recorded but not verified as a hive inhabitant in Europe. The known hosts of *T. ornatus* include a number of genera of solitary bees and also *Odynerus* and *Pseudomasaris* in the Vespidae. Linsley and MacSwain found that the larvae were able to complete their growth on *Odynerus* prepupae in five weeks but required 17 weeks to develop on pollen.

It is known that as an adult this clerid inhabits flowers (especially composites), where it feeds on pollen and living insects and oviposits on the undersides of the capitula. The first-instar larvae presumably attach themselves to visiting Hymenoptera and are carried back to the nests. The larva found in the can of pollen was probably carried to the hive in this manner and then scraped off by the pollen trap screen. It seems surprising that *Trichodes* larvae do not more frequently become established in honey bee colonies.

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[1]U.S.D.A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine in cooperation with the Utah Agricultural Experiment Station.

[2]Linsley, E. G., and J. W. MacSwain. Observations on the life history of Trichodes ornatus (Coleoptera, Cleridae), a larval predator in the nests of bees and wasps. Ann. Ent. Soc. Amer. 36(4):589-601. 1943.